Center Innovation Fund: LaRC CIF

Single-layer Ultralight, Flexible, Shielding Tension Shell System for Extreme Heat and Radiation

Completed Technology Project (2015 - 2017)

Project Introduction

The objective of this project is to develop a flexible thermal protection system (FTPS) with a Boron Nitride Nanotube (BNNT)-based single-layer, lightweight, flexible, shielding tension shell system. Lightweight, flexible, long BNNTs offer weight reduction, extreme thermal stability, effective radiation shielding, excellent mechanical durability, high thermal emissivity/conductivity, and radio frequency (RF)-signal transparency, enabling advanced entry, descent and landing (EDL) on planets and permits significantly increased payload.

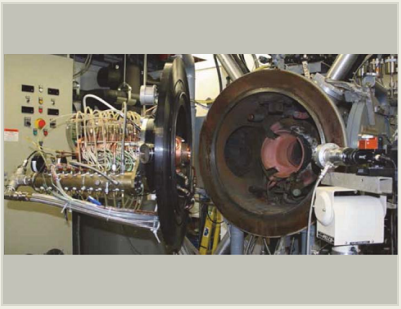
To protect astronauts, space structures and vehicles from the harsh space environment, lightweight, mechanically-robust, conformal, FTPS is required for future NASA space exploration. The objective of this effort is to develop and demonstrate a simplified, single-layer lightweight flexible shielding system, without an insulation layer and bladder, to meet FTPS challenges of weight reduction, thermal stability, mechanical durability, thermal management, and RF-signal transparency. BNNTs offer lightweight density, extreme thermal stability, excellent thermal conductivity and emissivity along with excellent mechanical durability and radiation shielding capabilities. In FY15, fabrication of BNNTs into tailored forms (ex. BNNT mats and foams) has been successfully demonstrated and improved by a co-solvent dispersion method. Preliminary testing on the Hypersonic Materials Environmental Test System (HYMETS) was performed with the BNNT material being exposed to a simulated high thermal flux for a planet entry. The material survived for the designed duration with minimal damage to the BNNT material. Highly aligned BNNT yarn spinning has also been studied in an effort to build a tension shell fabric in collaboration with Rice University. The FY16 project plan proposes the development of BNNT-based advanced FTPS test samples, including mat formation and alignment and yarn formation and spinning; optimization of BNNT FTPS test samples; characterization and property measurements of FTPS samples (toughness and mechanical properties at high temperatures,thermal stability, thermal conductivity, and thermal emissivity). Additional HYMETS tests are also planned in FY16.

Anticipated Benefits

Lightweight, mechanically-robust, conformal, FTPS will benefit future NASA space exploration: by protecting astronauts, space structures and vehicles from the harsh space environment. Replacing the SOA 3-layer TPS with a single layer BNNT based FTPS tension shell will provide over a 30% weight savings with increased performance and a higher density packing for smaller space vehicles.

Maximize payload for space exploration vehicles, which extend the destination and enable future human space exploration.

A lightweight, compact, deployable BNNT-based FTPS offers increased payload and improved shielding capability against thermal flux and radiation, enabling



LaRC HYMETS facility

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

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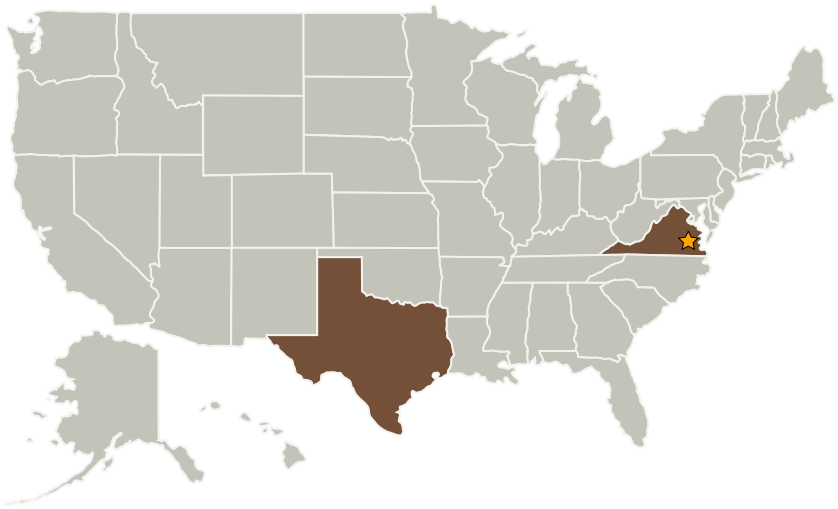
safer and more affordable space travel.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia

Co-Funding Partners	Type	Location
National Institute of Aerospace	Academia	Hampton, Virginia
Rice University	Academia	Houston, Texas

Primary U.S. Work Locations	
Texas	Virginia

Project Management

Program Director:
Michael R Lapointe

Program Manager:
Julie A Williams-byrd

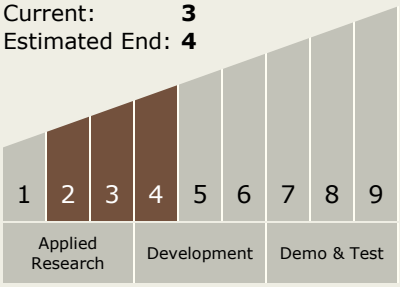
Project Manager:
Catharine C Fay

Principal Investigator:
Sang-hyon Chu

Co-Investigator:
Catharine C Fay

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.3 Thermal Protection Components and Systems
    - TX14.3.1 Thermal Protection Materials

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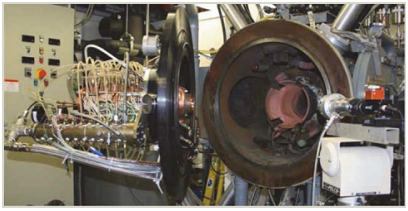
Images

BNNT material
BNNT material before and after HYMETS test with minimal damage to the exposed surface after the test.
(https://techport.nasa.gov/image/16795)



LaRC HYMETS facility
LaRC HYMETS facility
(https://techport.nasa.gov/image/16794)